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IMAGING SPECTRUM OF TESTICULAR TUMOURS ON DOPPLER SONOGRAPHY

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Keywords:

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ABSTRACT: This study investigates the imaging characteristics of testicular tumors through the use of Doppler sonography, emphasizing its significance as a first-line, non-invasive diagnostic modality for the evaluation of testicular masses. Testicular tumors represent a significant clinical concern due to their potential malignancy and impact on male reproductive health. High-resolution ultrasonography combined with color and spectral Doppler imaging, offers comprehensive insights into both the morphological structure and vascularity of testicular lesions. This dual approach enhances the clinician's ability to distinguish between benign and malignant pathologies. The study presents a detailed analysis of seven clinically suspected cases of testicular tumors, encompassing a range of histopathological types such as lymphoma, sex cord-stromal tumors, and various non-seminomatous germ cell tumors (including yolk sac tumors, embryonal carcinomas, teratomas, and mixed germ cell tumors), as well as seminomas. Sonographic features observed in malignant tumors include heterogeneous echotexture, increased internal vascularity, and the presence of retroperitoneal lymphadenopathy, which are key indicators of aggressive disease. The findings demonstrate that Doppler ultrasound is not only effective in the initial detection of testicular tumors but also plays a crucial role in their characterization and in guiding further management strategies. By providing real-time, detailed vascular and structural information, Doppler sonography aids in narrowing differential diagnoses, planning surgical intervention and monitoring treatment response. This study reinforces the importance of incorporating Doppler imaging into routine scrotal evaluations, thereby improving the early diagnosis and clinical outcomes of patients with testicular neoplasms.

INTRODUCTION:

Ultrasonography with Doppler: The First-Line Imaging Modality: When assessing testicular neoplasms, ultrasound (USG) in conjunction with Doppler imaging is commonly considered the first imaging modality of choice.

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It is perfect for assessing scrotal and testicular pathology because it is non-invasive, accessible, affordable, and does not use ionizing radiation [1]. High-frequency transducers provide excellent spatial resolution, enabling detailed visualization of testicular parenchyma and identification of intratesticular lesions.

When combined with color and spectral Doppler, it offers additional functional information about the vascularity of testicular lesions, which is vital for distinguishing between benign and malignant tumors [2].

Color Doppler assesses the presence and pattern of blood flow within a lesion. Malignant testicular tumors typically demonstrate increased internal vascularity due to neovascularization, while benign lesions may be a vascular or show peripheral flow. Spectral Doppler can further provide quantitative parameters such as resistive index (RI) and peak systolic velocity (PSV), which may aid in characterizing lesions [3].

Classification of Testicular Neoplasms: Based on their histology, testicular neoplasms can be generically classified as seminomatous or non-seminomatous germ cell tumours (NSGCTs) [4]. This classification is essential because it guides clinical management, prognosis, and therapeutic response [5].

Seminomas are the most common type of testicular germ cell tumors in adults. On sonography, they usually appear as homogeneous, hypoechoic masses with well-defined margins. Doppler imaging typically reveals increased internal vascularity, but the flow pattern is usually less chaotic than in non-seminomatous tumors [6].

Non-seminomatous germ cell tumors (NSGCTs) [7] include several subtypes such as:

1. The most prevalent testicular tumours in children are yolk sac tumours. They may exhibit abundant vascularity on Doppler imaging and frequently show up as heterogeneous masses with mixed echogenicity on ultrasound [8].
2. **Embryonal Cell Carcinoma:** These are aggressive tumors with a heterogeneous appearance on ultrasound due to areas of haemorrhage and necrosis. Doppler often shows marked hypervascularity with chaotic blood flow.
3. **Teratomas:** These contain elements from multiple germ layers and appear as complex cystic-solid masses, often with calcifications. Their vascularity on Doppler can vary depending on the composition.
4. **Mixed Germ Cell Tumors:** Combinations of the above elements, frequently observed, showing variable imaging characteristics on ultrasound and Doppler.

Sex Cord-Stromal Tumors [9] such as:

1. Sertoli Cell Tumors and Leydig Cell Tumors are relatively rare and often present as small, well-circumscribed hypoechoic nodules. They are typically hypervascular on Doppler imaging.
2. Lymphoma, particularly in older men, is another important testicular tumor. It may appear as diffuse testicular enlargement or as discrete hypoechoic lesions [10]. On Doppler, lymphomas usually exhibit marked internal vascularity.

Objectives of the Study: To illustrate the Ultrasound and Doppler findings in testicular tumour.

Methodology: The present study was conducted on a total of seven male patients who presented with clinically suspected testicular mass lesions. Each of these patients underwent a comprehensive clinical evaluation, followed by diagnostic imaging procedures to confirm and characterize the nature of the testicular abnormalities. The primary imaging modality utilized for all seven patients was high-resolution ultrasonography, combined with color and spectral Doppler sonography. This approach enabled the assessment of both the morphological features of the testicular masses and their vascular characteristics, which are essential for differentiating benign from malignant lesions.

Five of the seven patients had contrast-enhanced computed tomography (CT) of the abdomen and pelvis in addition to sonographic examination. CT imaging was especially helpful in staging probable malignant testicular tumours and in assessing possible retroperitoneal lymphadenopathy and metastatic dissemination.

The selection of patients for CT imaging was based on clinical suspicion of advanced disease or findings suggestive of malignancy on initial ultrasound and Doppler evaluation. This multimodality imaging strategy provided a thorough evaluation of testicular masses, allowing for accurate diagnosis, staging, and planning of further management.

RESULTS:

TABLE 1: SAMPLE SIZE DISTRIBUTION

Category	Number of Cases (n)	Percentage (%)
Paediatric Patients (0–12 years)	11	44%
Adolescents (13–18 years)	7	28%
Young Adults (19–25 years)	7	28%
Total	25	100%

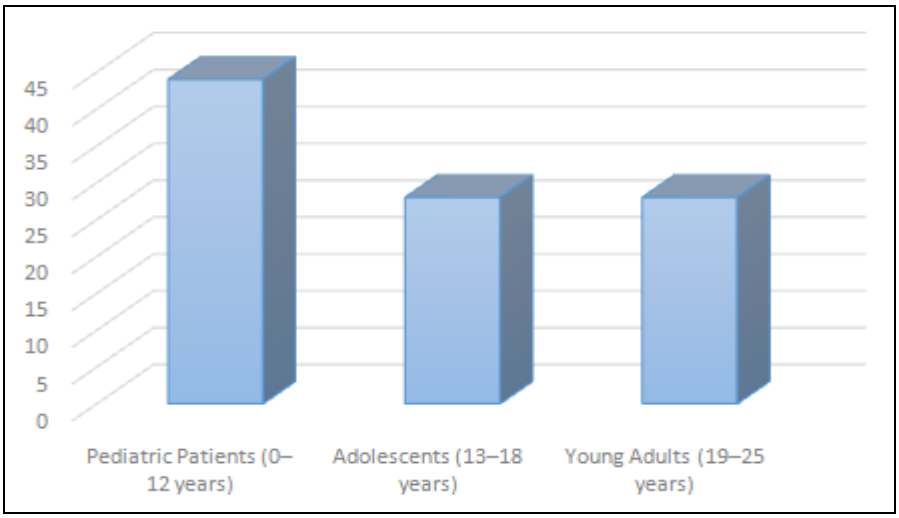


FIG. 1: GRAPHICAL REPRESENTATION OF SAMPLE SIZE DISTRIBUTION

The sample consists of 25 cases of testicular tumors, with the highest proportion seen in paediatric patients (0–12 years), accounting for 44% of the total. Adolescents (13–18 years) and young adults (19–25 years) each represent 28% of the cases. This indicates that testicular tumors are more commonly observed in the paediatric age group in this study population.

TABLE 2: SAMPLE SIZE BY DIAGNOSIS

Diagnosis	Number of Cases (n)	Percentage (%)
Yolk Sac Tumor	7	28%
Teratoma	4	16%
Mixed Germ Cell Tumor (Mixed GCT)	7	28%
Seminoma	4	16%
Testicular Lymphoma	3	12%
Total	25	100%

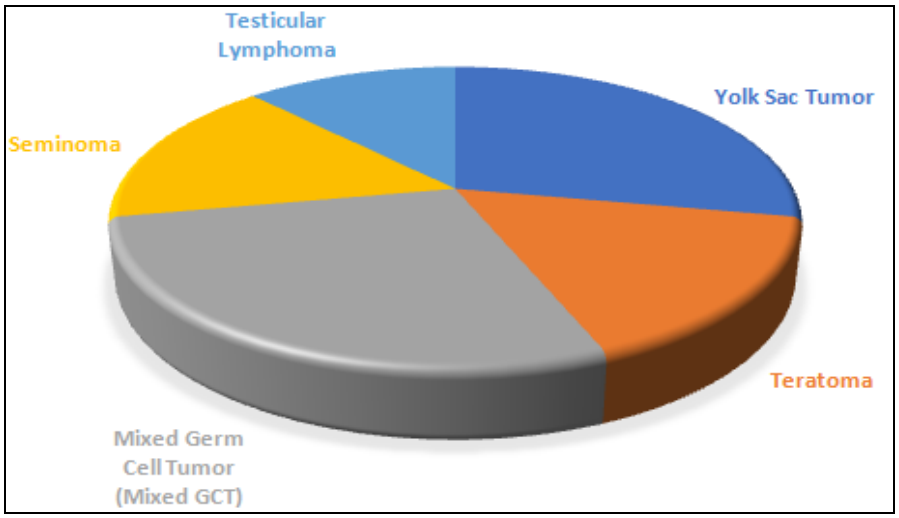


FIG. 2: GRAPHICAL REPRESENTATION OF SAMPLE SIZE BY DIAGNOSIS

Table 2 shows that among the 25 testicular tumor cases, Yolk Sac Tumor and Mixed Germ Cell Tumor were the most common diagnoses, each accounting for 28% of the cases. Teratoma and Seminoma were observed in 16% of cases each, while Testicular Lymphoma was the least common, comprising 12%. This distribution highlights the predominance of germ cell tumors in the sample.

Case 1- Testicular Teratoma: A 16-year-old male with a history of right-sided orchiopexy for undescended testis three years ago presented with left scrotal swelling. On examination, the right testis was not palpable, suggesting possible failed orchiopexy, retraction, or atrophy. The left swelling raised concern for a mass, infection, or hydrocele. Given the history of cryptorchidism, an established risk factor for testicular malignancy further evaluation with ultrasound and Doppler was warranted to assess both testes and rule out malignancy.

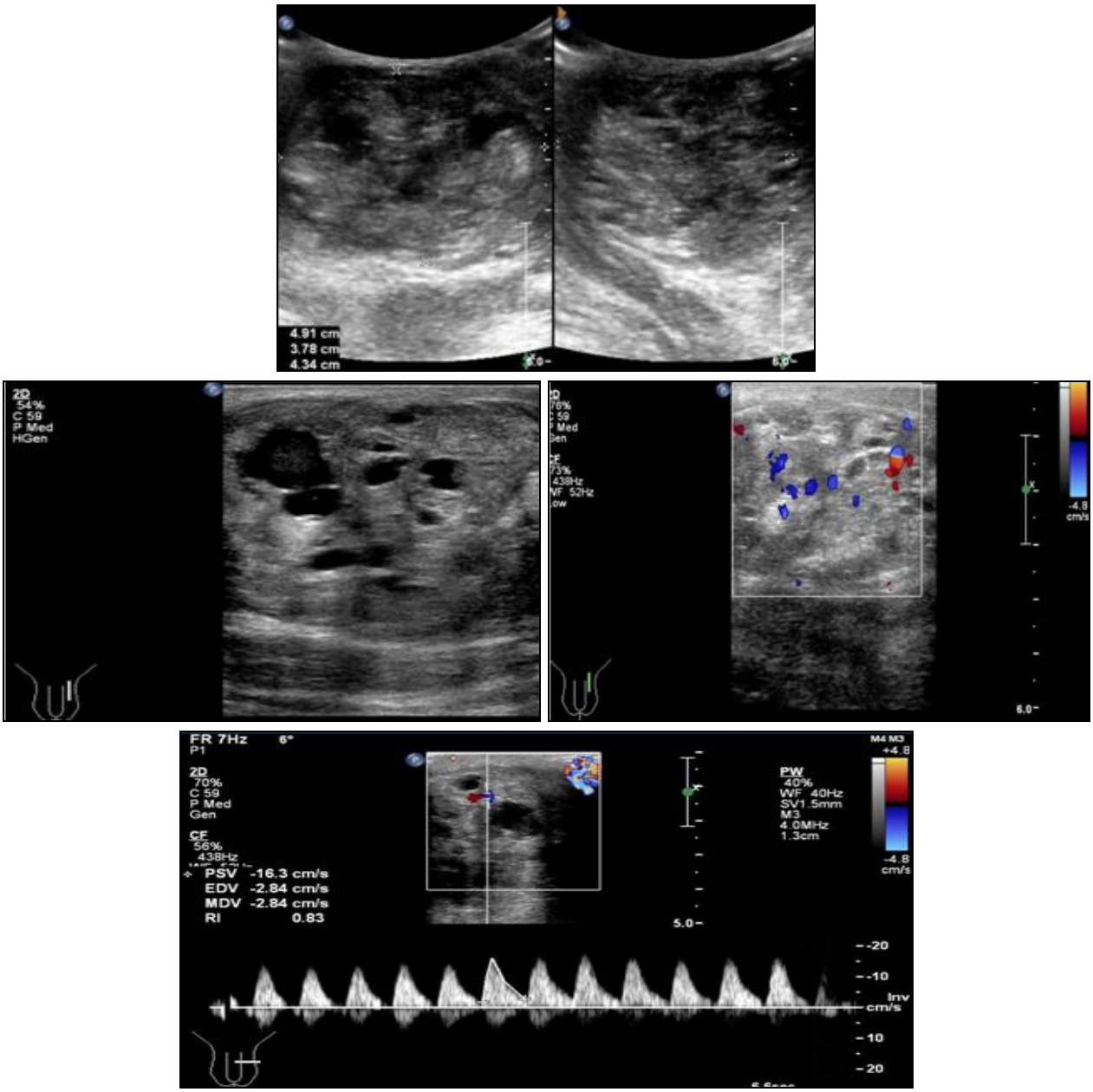


FIG. 3: ULTRASOUND IMAGING SHOWED A BULKY AND HETEROGENEOUS LEFT TESTIS WITH BOTH SOLID AND CYSTIC AREAS AND MILDLY INCREASED PREDOMINANTLY ARTERIAL VASCULARITY. THESE FINDINGS ARE SUSPICIOUS FOR A TESTICULAR TUMOR, POSSIBLY A GERM CELL TUMOR. GIVEN THE HISTORY OF CRYPTORCHIDISM AND CURRENT ULTRASOUND FEATURES, FURTHER EVALUATION WITH TUMOR MARKERS AND IMAGING IS RECOMMENDED, ALONG WITH REFERRAL TO UROLOGY FOR DEFINITIVE MANAGEMENT

Case 2- Mixed Germ Cell Tumour: A male patient, age 18, had a palpable tumour in the right hypogastric area. Alpha-fetoprotein (AFP) levels were found to be high in laboratory examinations. These findings are suggestive of a possible germ cell tumor, likely of testicular origin (such as a non-seminomatous germ cell tumor), with potential retroperitoneal or abdominal metastasis. Further imaging and biopsy are necessary for confirmation and treatment planning.

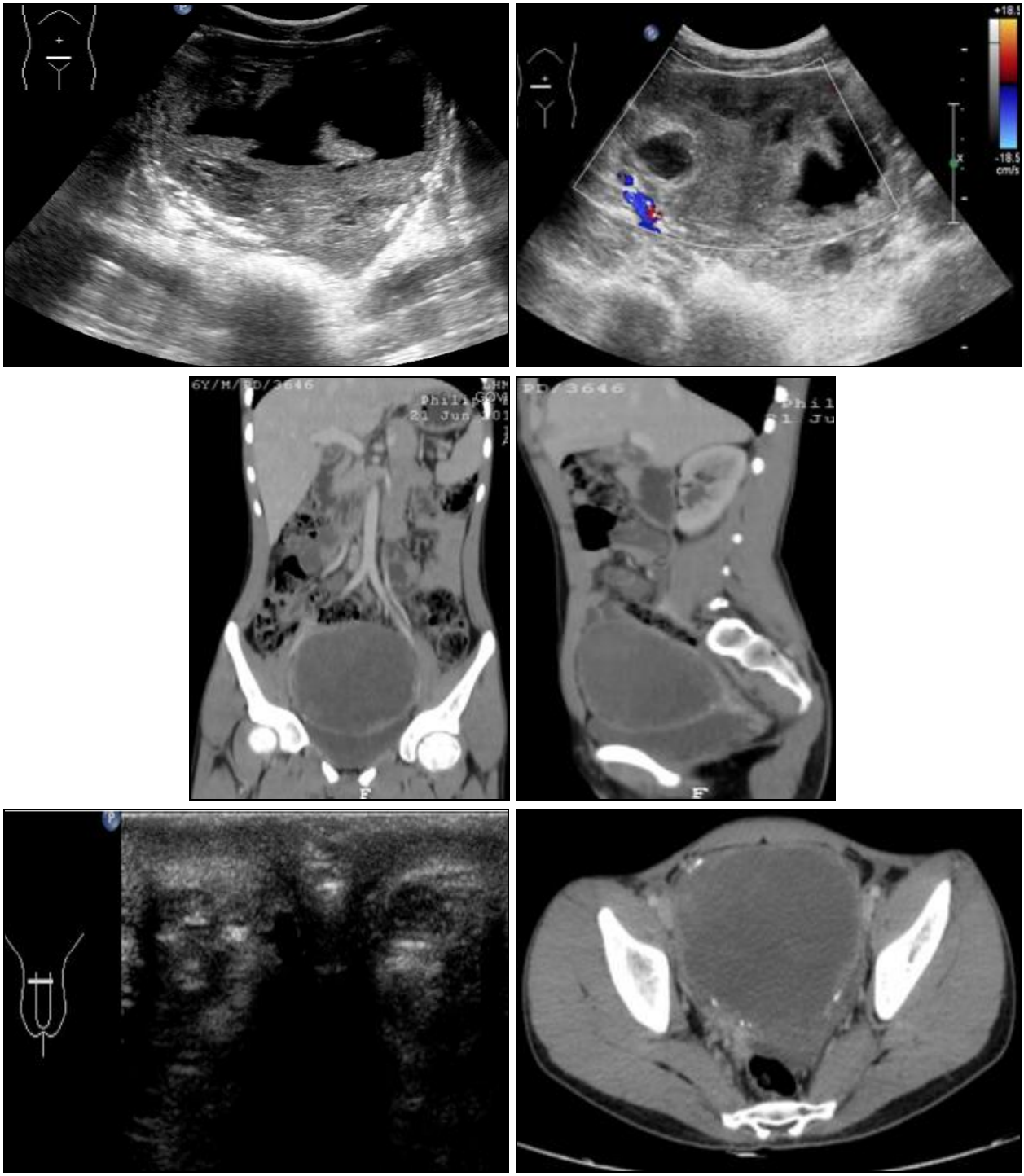


FIG. 4: ULTRASOUND IMAGING REVEALED EMPTY BILATERAL SCROTAL SACS AND A WELL-DEFINED SOLID HETEROECHOIC PELVIC LESION LOCATED POSTERIOR AND SUPERIOR TO THE BLADDER, CONTAINING CYSTIC AREAS AND LACKING SIGNIFICANT INTERNAL VASCULARITY. NCCT SHOWED A CYSTIC PELVIC LESION WITH WALL CALCIFICATIONS, WHILE CECT DEMONSTRATED A HETEROGENEOUS LESION WITH SOME ENHANCING REGIONS. FNAC FINDINGS OF NON-SEMINOMATOUS GERM CELLS WERE HIGHLY SUGGESTIVE OF A MIXED GERM CELL TUMOR (GCT)

Case 3- Yolk Sac Tumour: A 3-year-old boy had an abdominal tumour and oedema in his left scrotum. The most prevalent testicular tumor in this age range, a yolk sac tumour, was suspected due to elevated alpha-fetoprotein (AFP) values. Imaging was essential for diagnosis and treatment planning.

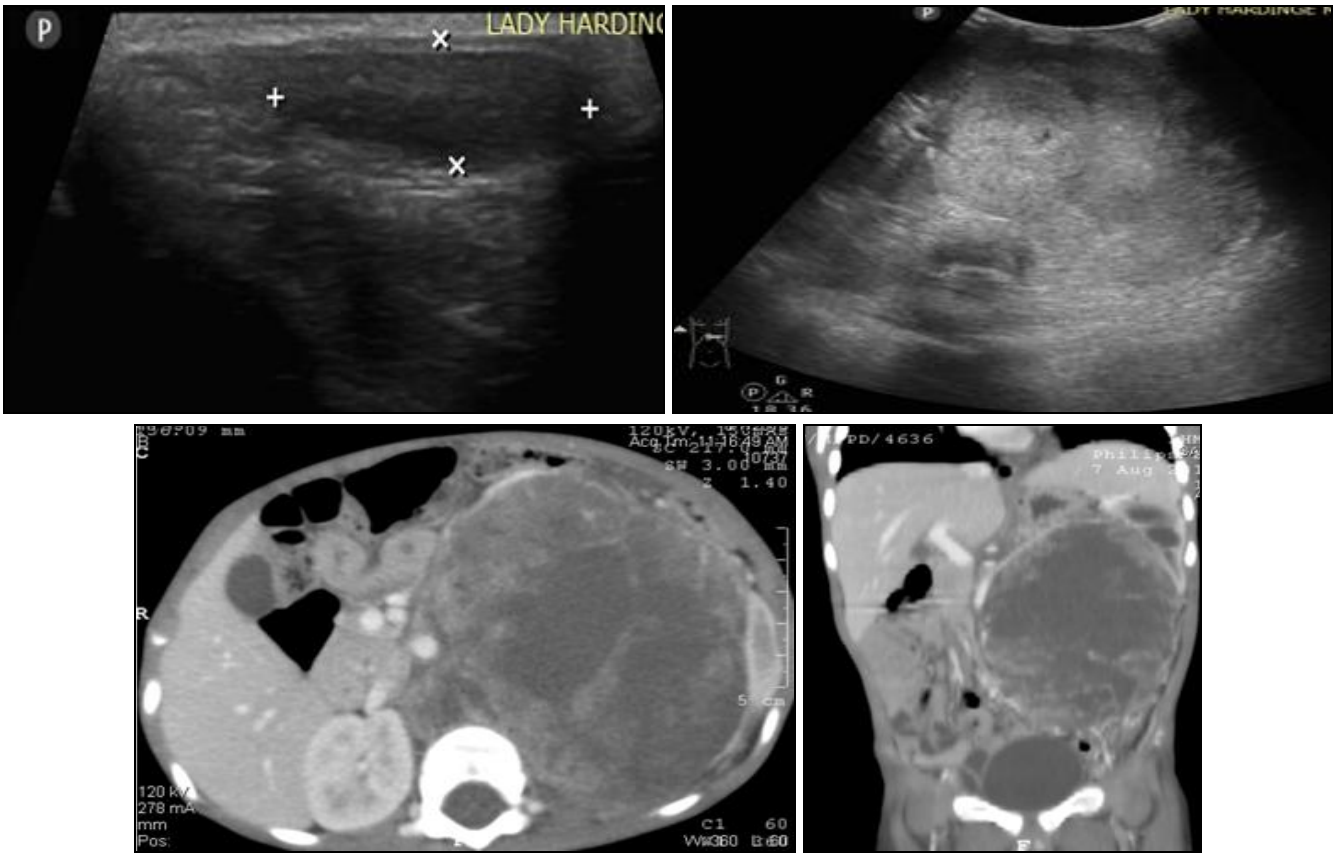
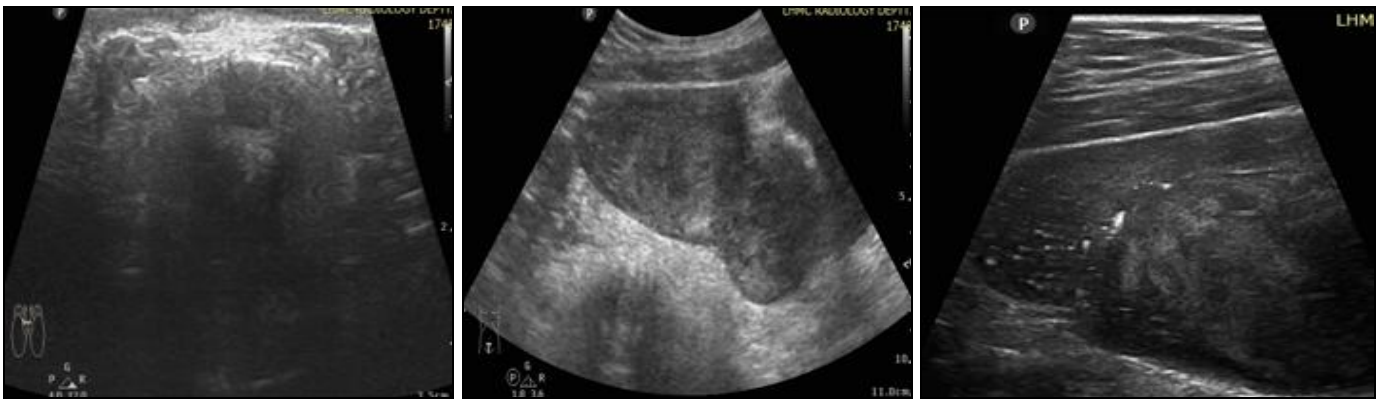


FIG. 5: THE SCROTAL ULTRASONOGRAPHY (USG) SHOWED A TINY RIGHT TESTIS AND A LARGER, HYPOECHOIC LEFT TESTIS WITH INCREASED INTERNAL BLOOD FLOW, SUGGESTING AN ABERRANT MASS. A BIG, WELL-DEFINED, HETEROECHOIC RETROPERITONEAL LYMPH NODE WAS ALSO SEEN ON THE ABDOMINAL USG, WHICH MAY INDICATE LYMPHATIC SPREAD. AN ABDOMINAL CONTRAST-ENHANCED CT (CECT) SCAN REVEALED A DISTINCT, IRREGULARLY ENHANCING RETROPERITONEAL LYMPH NODE MASS. THE PATIENT HAD A HIGH INGUINAL ORCHIDECTOMY AS A RESULT OF THESE DISCOVERIES, AND A HISTOLOGICAL ANALYSIS REVEALED THAT THE TUMOUR WAS A MALIGNANT GERM CELL TUMOUR OF THE YOLK SAC. IN ORDER TO TREAT METASTATIC DISEASE AND LOWER THE CHANCE OF RECURRENCE, THE PATIENT WAS PUT ON CHEMOTHERAPY AFTER SURGERY

Case 4 – Seminoma: A 28-year-old male with absent bilateral testes and dull pelvic pain has raised serum LDH, suggesting possible testicular pathology or malignancy. Further evaluation is needed.



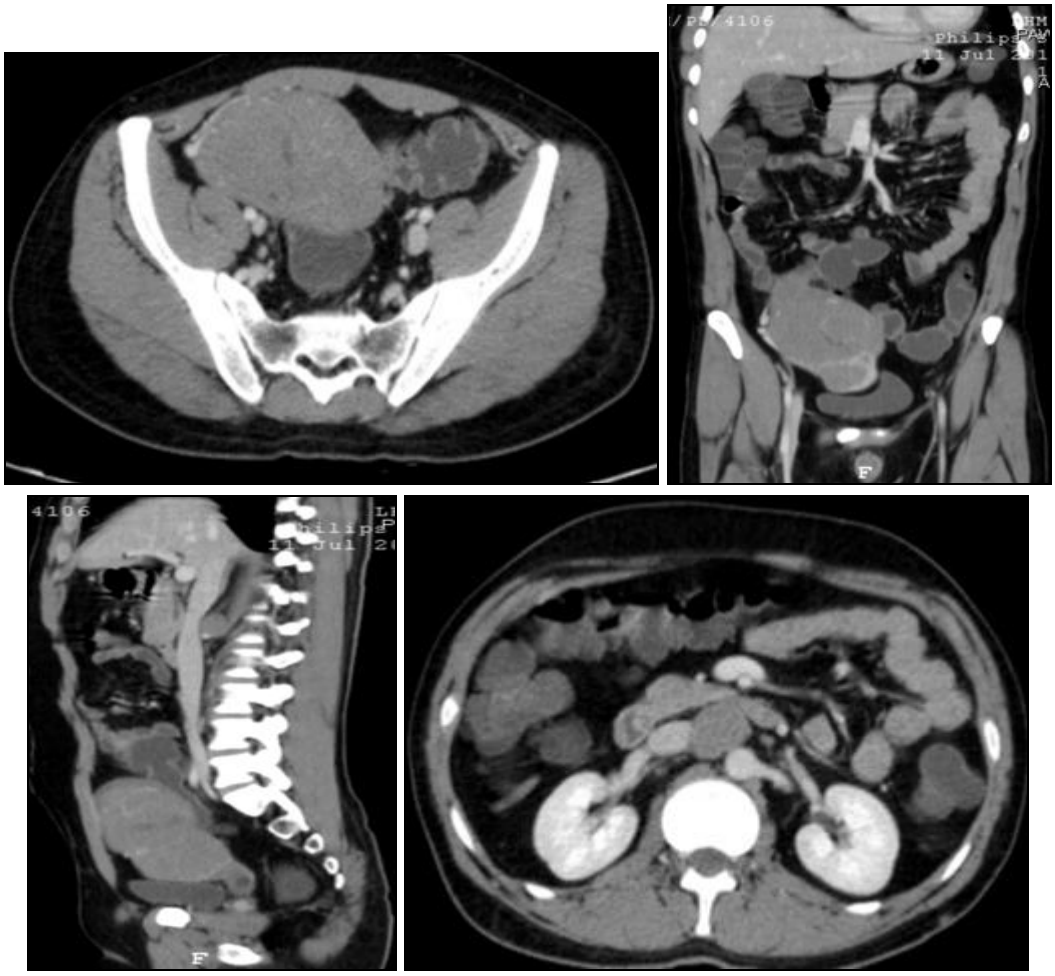
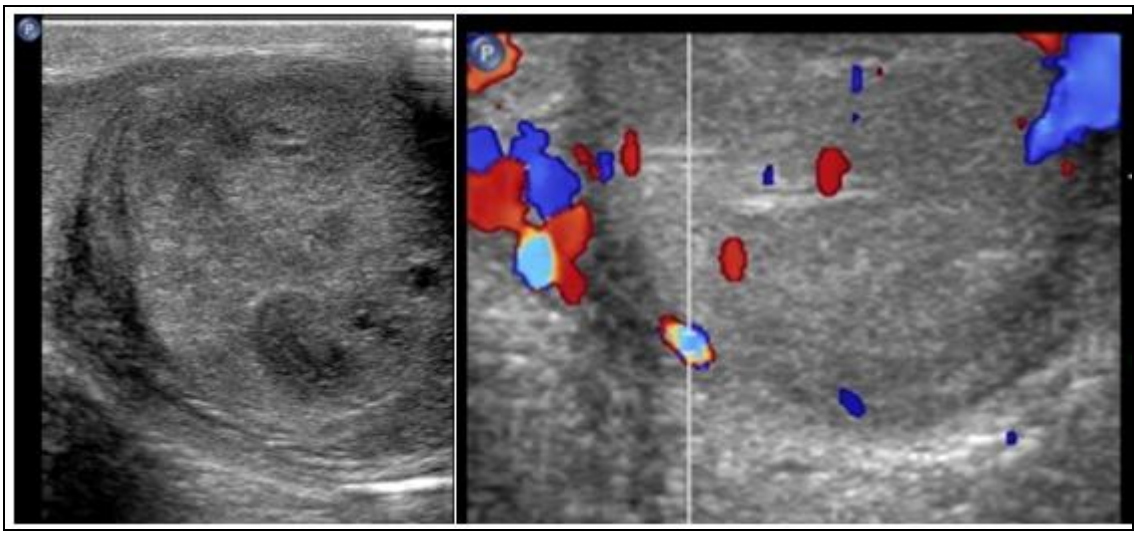


FIG. 6: THE USG SCROTUM SHOWS ABSENT TESTES IN BOTH SCROTAL SACS. ABDOMINAL USG REVEALS A LARGE, WELL-DEFINED BILOBED SOLID HYPOECHOIC LESION WITH CALCIFICATIONS IN THE ABDOMINOPELVIC REGION. CECT IMAGES DEMONSTRATE A WELL-DEFINED, BILOBED, HOMOGENEOUSLY ENHANCING SOLID MASS LOCATED BEHIND AND ABOVE THE URINARY BLADDER, EXTENDING FROM L5 TO S4 VERTEBRAL LEVELS. ADDITIONALLY, AN ENLARGED RETROPERITONEAL LYMPH NODE IS NOTED ON CECT. HISTOPATHOLOGY CONFIRMED THE DIAGNOSIS OF SEMINOMA

Case 5- Yolk Sac Tumour with Metastasis: A 3-year-old male child presents with right scrotal swelling and elevated serum AFP levels, suggesting a possible testicular tumor, likely a yolk sac tumor. Further imaging and evaluation are needed for diagnosis and treatment planning.



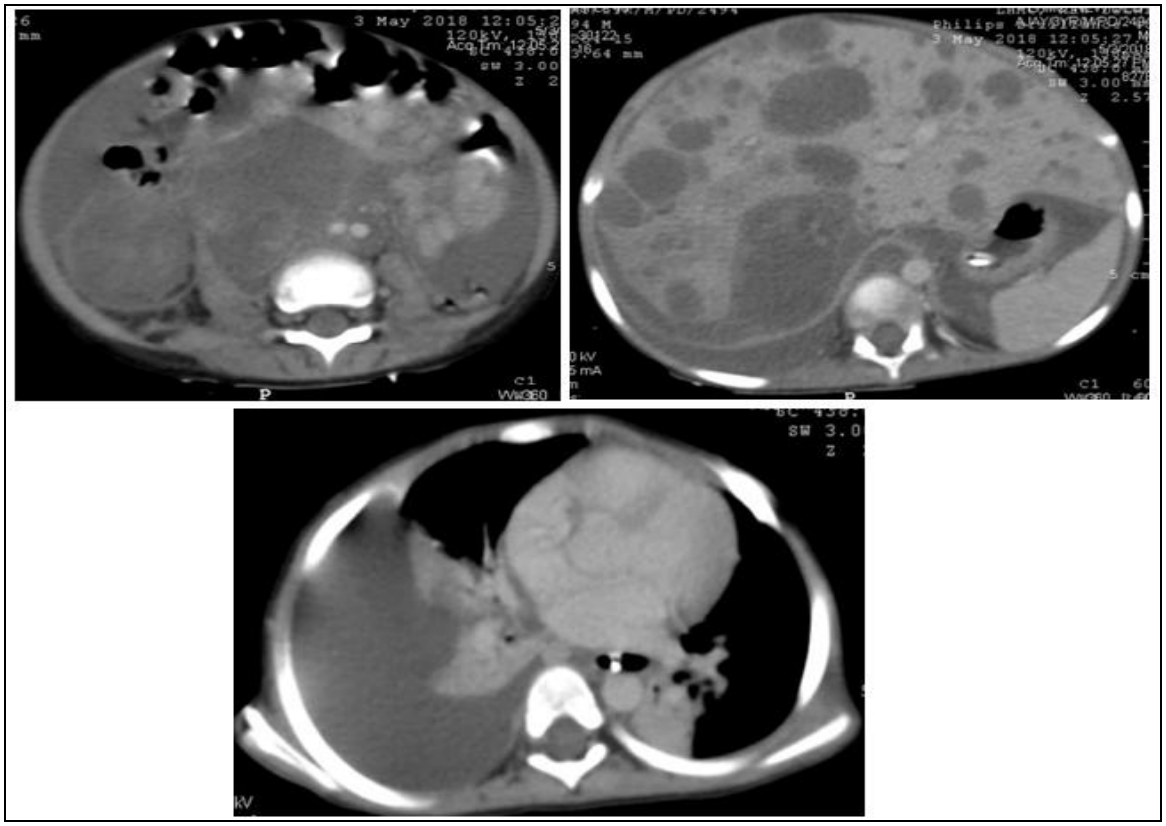
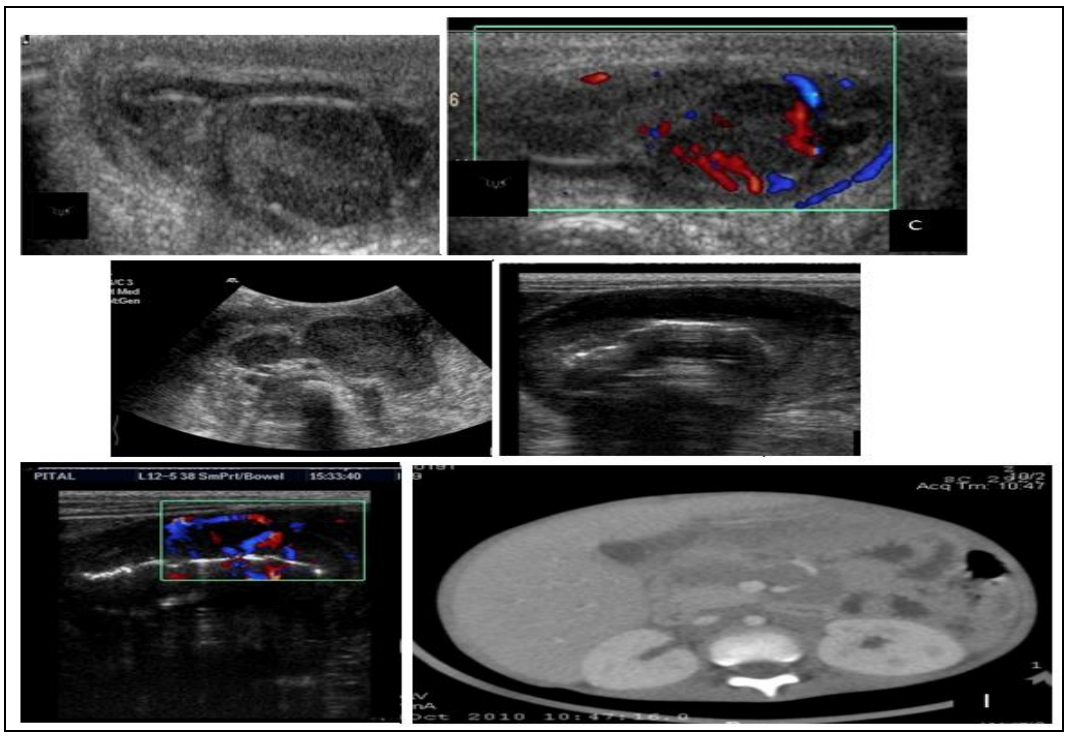


FIG. 7: USG SCROTUM SHOWS THE NORMAL LEFT TESTIS REPLACED BY A SOLID HETEROGENEOUS MASS WITH NECROTIC AREAS AND MINIMAL BLOOD FLOW. CECT ABDOMEN REVEALS A HETEROGENEOUSLY ENHANCING RETROPERITONEAL LYMPH NODE MASS AFFECTING THE RIGHT KIDNEY, MULTIPLE HYPODENSE LIVER LESIONS INDICATING METASTASES WITH ASCITES, AND RIGHT PLEURAL EFFUSION. THE PATIENT UNDERWENT HIGH INGUINAL ORCHIDECTOMY AND STARTED CHEMOTHERAPY. HISTOPATHOLOGY CONFIRMED A YOLK SAC TUMOR

Case 6-Testicular Lymphoma: A 5-year-old male presents with fever and an abdominal lump, which may indicate an underlying infection, tumor, or other abdominal pathology.



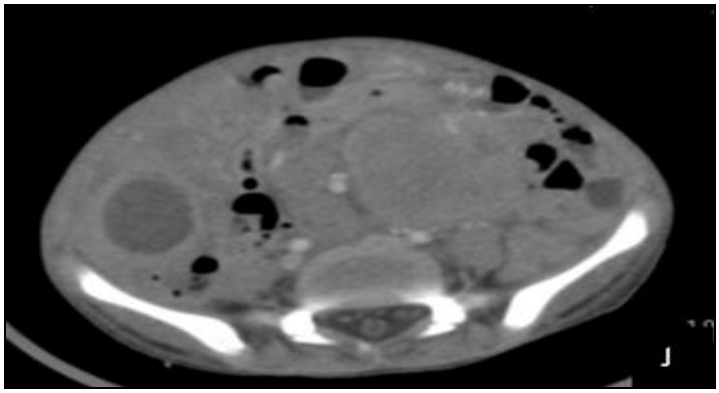


FIG. 8: ON THE USG SCROTUM, THE RIGHT TESTIS IS ENLARGED, AND THERE IS A LOCALISED HYPOECHOIC LESION IN THE LOWER POLE THAT HAS MILD HYDROCELE AND ENHANCED VASCULARITY. MULTIPLE ENLARGED RETROPERITONEAL LYMPH NODES AND VASCULAR THICKENING OF THE TERMINAL ILEUM ARE SEEN ON ABDOMINAL ULTRASONOGRAPHY. BOWEL THICKENING AND ENLARGED RETROPERITONEAL NODES ARE CONFIRMED BY CECT. A BIOPSY OF THE BONE MARROW REVEALED NON-HODGKIN'S LYMPHOMA

Case 7- Mixed GCT: A 22-year-old male presents with scrotal swelling and pain, along with elevated serum alpha-fetoprotein (AFP) and beta-HCG levels, suggesting a testicular germ cell tumor.

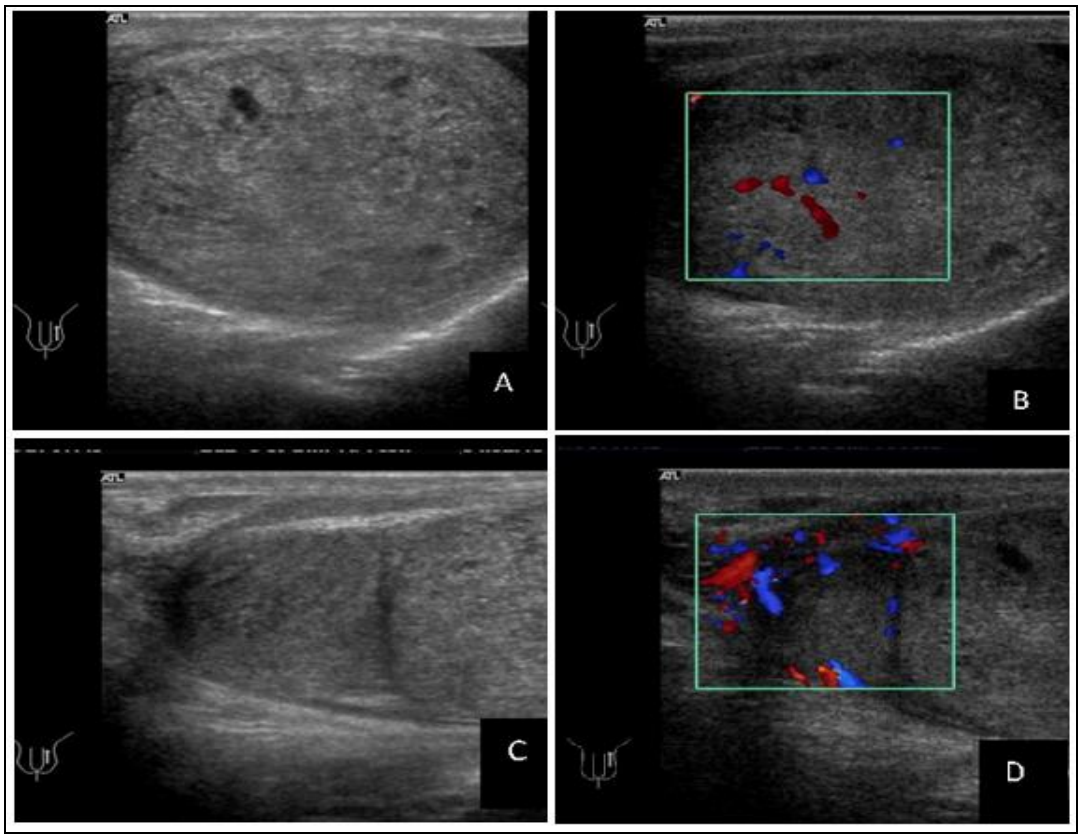


FIG. 9: THE LONGITUDINAL USG SCROTUM IMAGES REVEAL AN ENLARGED AND HETEROGENEOUS LEFT TESTIS ALONG WITH THE EPIDIDYMIS, BOTH REPLACED BY A SOLID MASS LESION. COLOR DOPPLER IMAGING SHOWS INCREASED VASCULARITY WITHIN THE LESION, INDICATING HIGH BLOOD FLOW TYPICAL OF MALIGNANT TUMORS. THESE FINDINGS ARE SUGGESTIVE OF A TESTICULAR NEOPLASM INVOLVING BOTH THE TESTIS AND EPIDIDYMIS, RAISING SUSPICION FOR A GERM CELL TUMOR. THE PATIENT UNDERWENT A HIGH INGUINAL ORCHIDECTOMY, WHICH IS THE STANDARD SURGICAL TREATMENT FOR SUSPECTED TESTICULAR TUMORS TO PREVENT LOCAL AND SYSTEMIC SPREAD. HISTOPATHOLOGICAL ANALYSIS OF THE REMOVED TISSUE CONFIRMED THE DIAGNOSIS OF A MIXED GERM CELL TUMOR, A MALIGNANCY COMPOSED OF MULTIPLE GERM CELL TUMOR TYPES. THIS DIAGNOSIS HELPS GUIDE FURTHER TREATMENT, INCLUDING CHEMOTHERAPY AND CLOSE FOLLOW-UP BASED ON TUMOR SUBTYPE AND DISEASE STAGE

CONCLUSION: USG scrotum is highly sensitive in differentiating scrotal masses as testicular or extra testicular and distinguishing solid from cystic lesions. Seminomas typically appear as solid, round, homogeneous masses with low reflectivity and no calcifications, reflecting their uniform cellular nature; color Doppler ultrasound (CDUS) usually shows vascularity within the lesion. Non-seminomatous germ cell tumors (NSGCT) tend to be heterogeneous, inhomogeneous masses with areas of increased echogenicity, calcifications, and cystic changes, with variable vascularity on CDUS. Mature teratomas often appear cystic with heterogeneous internal echoes due to mucinous or sebaceous material, sometimes containing hair follicles, and have solid components of mixed echogenicity, including hyperechoic fatty areas that may cause shadowing. Sonographically, both lymphoma and leukaemia can present as focal or multifocal hypoechoic lesions within the testis, making them difficult to distinguish from germ cell tumors based on imaging alone.

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